IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

REVIEW ON "TRADITIONAL PROCESSING METHODS FOR INCREASING BIOAVAILABILITY OF NUTRIENTS PRESENT IN QUINOA"

[1]Aaysha Tahera Khan
Assistant Professor
Department of Home Science
Govt. MLB Girls P.G. College, Kila Bhawan Indore (M.P.), India

Abstract : Quinoa (Chenopodium Quinoa Wild, Amaranthaceae) is a stress-tolerant pseudo cereal. It is an ancient grain that has provided subsistence, medicine, and nutrition to the Andean culture for thousands of years. Quinoa is a wonder grain that contains all Macro and micronutrients beneficial for human health. Quinoa is a package of proteins containing all 9 essential amino acids with high biological value, as well as it is a rich source of fiber, vitamins, minerals, phytochemicals, polyunsaturated fatty acids, and antioxidants. Despite all nutrients, content quinoa contains some antinutritional components (Saponins, Tannin, Phytic Acid, and Trypsin Inhibitors) that affect the bioavailability, Bio acceptability, and organoleptic properties of the super grain. This review paper focuses on some domestic processing methods (Dehulling, Soaking, Germination, Malting, and Fermentation) used to reduce antinutritional components present in quinoa.

.

Introduction:-

Quinoa (Chenopodium Quinoa Wild) is a pseudocereal that occurs mainly in the Andean region of South America and is consumed as the main crop in Bolivia (Vanesa Castro-Alba et al., 2019). Pseudocereals are dicotyledonous, gluten-free, and are considered a replacement for true cereals (Priyanka Thakur et al., 2021) Quinoa is widely known due to its high protein content and well-balanced amino acid profile composition as compared to wheat, barley, soybean, and rice (Viktoria Angeli et al.,2020). Quinoa is an excellent source of macronutrients, mainly protein with a superior content of all essential amino acids. (Ligen Wu et al.,2020) Quinoa is the only available grain with a natural amino acid balance in its protein, and in recent times, its popularity has risen in Europe, North America, and the Andean region primarily due to the needs of those adopting vegetarian diets and those with a bias towards gluten and lactose present in grains. Its high quality is proven by the presence of essential amino acids histidine, isoleucine, leucine, phenylalanine, threonine, tryptophan, valine, and, most notably, lysine and methionine. Its grains are high in minerals (K, Ca, P, Mn, Zn, Cu, Fe, Na), fibre, and vitamins C and E. Quinoa's nutritional qualities have decided to make it a reference crop, adaptable to various global growing conditions, and an option for increasing food security (FAO, 2011)). (Flívia Fernandes deet al.,2017). The amino acid composition is close to the ideal protein balance recommended by FAO and similar to milk (Antonio Manoel Maradini Filho., 2017). Due to its high biological value protein, Quinoa is considered a super food (Fatin Nadiah Saypol Anwer et al.,2021). Quinoa is an ancient grain now quinoa is considered a Super Grain in the current food market. The year 2013 was declared the "International Year of Quinoa" by the United Nations FAO(Savita Sharma et al., 2022)Quinoa contains Good quality carbohydrates, proteins, fats, vitamins, minerals, flavonoids, antioxidants, and carotenoids as nutritional components, and saponins, phytic acid, oxalates, trypsin inhibitors, and tannins as antinutritional components (Safiullah Pathan et al.,2022). In spite of being highly nutritious, these pseudocereals have limited bioavailability due to the presence of anti-nutritional components like tannins and phytic acid, that bind with nutrients and make them unavailable for the body (Hotz and Gibson,2007). In matured quinoa phytates have a high storage of phosphorus which impairs the absorption of zinc, iron, and calcium by making insoluble complexes. the endogenous part of grain contains *phytase* enzyme which can hydrolyze phytates. For the Activation of endogenous *phytase,* many processing technologies such as soaking, early-stage thermal treatment, germination, and fermentation can be applied(Venesa Casta-alba et al.,2019)

The simplest, most common, and cheapest methods for reducing antinutritional components and enhancing nutritional availability are soaking and germination (Priyanka Thakur et al.,2021).

With the reduction of antinutritional compounds processing techniques helps to improve, the texture and organoleptic properties of the final product due to improved functional properties (Savita Sharma et al.,2022)

Discussion

Some Specific Antinutritional Components Present in Quinoa:

Saponins

Saponins are non-volatile, surface-active secondary metabolites, which are broadly dispersed in nature but found principally in plants (Mrinal Samtiyaet al., 2020). The pericarp part of quinoa is rich in bitter saponins and should have to be removed by the mechanical or washing process before consumption of it. This process is called desaponification, dehusking, pearling, or milling (Brittany L. Grafet al.,2015). In quinoa amount of saponins varies between 0.1 and 5%. On the basis of saponin amount, quinoa is classified as free or 0.11% saponin is called sweet. Despite the fact that saponins have nutritional and pharmacological benefits, it has been identified as an anti-nutrient present in quinoa (Ozgur Kivilcim Kilinc et al., 2016).

Phytates:

Phytic acids naturally exist in the plant kingdom. In all plant-based foods, including cereals, legumes, nuts, and oilseeds, phytic acid is a secondary chemical that naturally concentrates in plant seeds (Mrinal Samtiya et al., 2020). Phytic acid is phosphate's storage form in plant seeds. Phytate has antinutritional effects on both humans and animals. due to the strong chelation of some minerals, such as zinc and iron, this results in insoluble complexes that are not absorbed by the body and create nutritional deficiencies. Preprocessing can enhance mineral absorption (Raushan Anand et al., 2021).

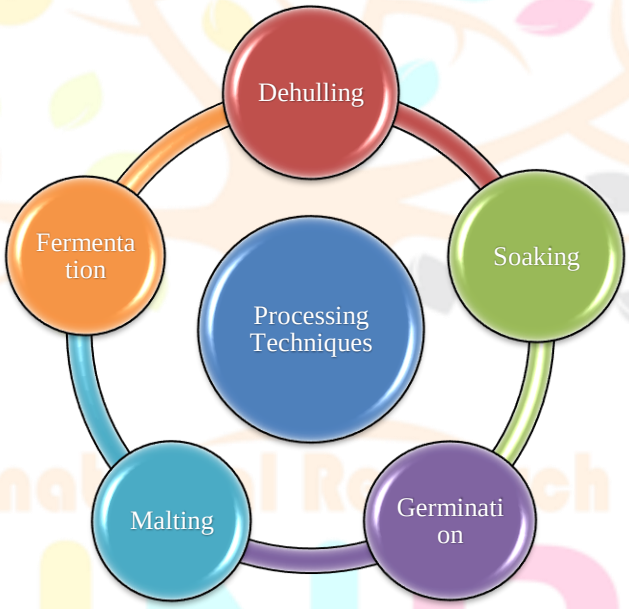
Tannins

Tannins are phenolic chemicals, and one of their characteristics is the ability to precipitate proteins. Tannins are secondary compounds that develop in the leaves, fruits, and bark of plants. Protein digestibility is typically impacted by tannins (Mrinal Samtiyaet al., 2020)

trypsin inhibitor

Two types of protease inhibitors, trypsin inhibitor, and Bowman-Birk inhibitor, are frequently found in soybean but are not easily destroyed by heat treatment because they include disulfide bridges (Mrinal Samtiya et al., 2020). Protein digestibility has been reduced by trypsin inhibitors. Trypsin inhibitors are polypeptide compounds that form stable complexes with trypsin in a one-to-one molar ratio and obstruct the enzymatic action. (Raushan Anand et al., 2021)

Different processing methods:



Dehulling

The outer seed layer of quinoa is rich in bitter saponins which is a natural detergent present in the plant kingdom. Because saponins affect the palatability and digestibility of quinoa, it is necessary to remove them before consumption (Brittany L. Graf et al., 2015). Post-harvesting and before placing market grains undergo processing like dehulling or decortication for removing the outer layer of the grain, which improves grain quality, and digestibility by lowering antinutritional components and improves palatability and acceptability of grain (N Nagasai Srujana et al.,2019). For better product and acceptability Dehulling technique is used. Dehulling helps to minimize cooking time. This technique has trivial effects on protein content and also improves protein digestibility by reducing trypsin inhibitors. Significantly dehulling removes fiber and tannins. (Sahar F. Deraz and Ashraf A. Khalil 2008). Hulls of the quinoa seeds contain 40-50% of saponins by a dehulling process almost half of the saponins of quinoa seeds are removed (G.S. Chouhan et al.,1992).

Soaking

Soaking is a process, used domestically to hydrate seeds in water for a few hours. various experiments show that the water-soluble antinutritional compound is removed by 12-18 hours of soaking in water (Embaby, 2010). The soaking process reduces tannin and is less effective for reducing phytic Acids and trypsin inhibitors (Sahar F. Deraz et al., 2008).

Germination

The germination process allows seeds to soak and maintains a moist environment until they get sprouted. Many studies have described that 24-48 hours of germination significantly enhance the nutritional profile and reduce the antinutritional component (Urbano et al.,2005). Tannin and phytate content could not be seen after steeping and germination (Kanensi et al.,2011). The germination technique improves phenolic compound as well as antioxidants which is used for functional food manufacturing (M Naga SaiSrujana et al.,2019). Germination is basically a catabolic process, growing plants get nutrition in this process on hydrolysis of reserved nutrients. during this process, phytic acid plays a role in the source of phosphorus and cations. The bioavailability of minerals may be affected by phytic acid hence germination may

help to enhance its bioavailability (A.S. Colmenares De Ruiz and Bressani., 1990). A study on value-added products by quinoa is done in which germinated quinoa seed flour chikki is prepared. the sensory evaluation of value-added products shows an 8.65 mean overall acceptability score. This study described that quinoa can be 100 percent acceptable in value-added products(S.M.Pritham et al., 2021). Despite the high nutritional quality of quinoa grains, processes such as germination and malting can improve this. In fact, germination (sprouting) has been shown to have numerous benefits in terms of increasing the nutritional quality of cereals and legumes. Sprouting, for example, increases the digestibility of starch and proteins in rice, corn, and barley. Many studies on quinoa have found that nutritional quality improves after germination. For example, phenolic compounds, flavonoids, and ascorbic acid content, as well as antioxidant capacity, can be increased during the germination process, resulting in seedlings with higher nutritional quality than non-germinated seeds(Julio Aguilar et al., 2019).

Malting

Malting is the process of germination under controlled conditions. Its main goal is to change the grain by mobilizing endogenous enzymes, as a result, physical and fast solubilization are facilitated during brewing, resulting in a nutritionally rich medium for yeast fermentation, which produces carbon dioxide and ethanol. The most important enzymes in malt hydrolysis are alpha and beta amylase, which cause the production of fermentable maltose from starch (Elisha Bwamu Kiptanui et al., 2022).

.

The steps of the malting process are hydration, germination, drying, and deculming (radicle cut). This process is mainly used in the production of fermented beverages from barley, sorghum, and others. However many studies show that malted cereal grains give several nutritional benefits in addition to germination alone (Julio Aguilar et al., 2019).

Malting is the controlled process of cereal, pulse, and seed germination. During this time, The grains generate enzymes such as diastatic enzymes which are required for the conversion of starch to sugars, such as disaccharides and monosaccharides respectively in sucrose or maltose and glucose or fructose. It also generates other enzymes, such as proteases, which degrade grain proteins Malting also improves grain quality by removing impurities, and components that are undesirable, such as antinutritional elements(Wanole PD et al., 2022).

Fermentation

Fermentation is a process in which primary food is modified biochemically by microorganism and their enzymes. The fermentation process is used to improve the bioaccessibility and availability of different crops and also enhance their organoleptic characteristics and improve their keeping quality(Smith G. Nkhata et al., 2018). Cereal fermentation is usually done for preservation, which comes from the production of acids. The acids include lactic, acetic, propionic, and propionic or alcohol production, which is frequently combined with a reduction in water activity, safety enhancement of the final products through inhibition of pathogenic microorganisms, enhancement of sensory properties (color, aroma, texture, and taste), nutritional value improvement through the removal of anti-nutrients such as tannins, phytic acid, enzyme inhibitors, and polyphenols, and bio-availability (Elisha Bwamu Kiptanuiet al., 2022)

Conclusion

In the present time, Quinoa is proving wonder grain due to its nutritional properties. For taking its true benefits it's necessary to make it biologically acceptable and available. Quinoa contains several antinutritional components that interfere with its availability to the body, so this article focuses on several processing methods that will be helpful to reduce the anti-nutritional components and improve its acceptability, palatability, and availability.

References

[1] Aguilar, J., Miano, A. C., Obregón, J., Soriano-Colchado, J., & Barraza-Jáuregui, G. (2019). Malting process as an alternative to obtain high nutritional quality quinoa flour. *Journal of Cereal Science*, *90*, 102858. https://doi.org/https://doi.org/10.1016/j.jcs.2019.102858

[2] Anand, R. (2021). *Plant Based Antinutrients: A Review* (Vol. 9). www.ijcrt.org

[3] Castro-Alba, V., Lazarte, C. E., Perez-Rea, D., Sandberg, A. S., Carlsson, N. G., Almgren, A., Bergenståhl, B., & Granfeldt, Y. (2019). Effect of fermentation and dry roasting on the nutritional quality and sensory attributes of quinoa. *Food Science and Nutrition*, *7*(12), 3902–3911. https://doi.org/10.1002/fsn3.1247

[4] Colmenares De Ruiz', A. S., & Bressani, R. (1990). *Effect of Germination on the Chemical Composition and Nutritive Value of Amaranth Grain*.

[5] Deraz, S. F., & Khalil, A. A. (n.d.). *Strategies to Improve Protein Quality and Reduce Antinutritional Factors in Mung Bean*.

[6] El-Sayed, H. (2011). Effect of Heat Treatments on Certain Antinutrients and in vitro Protein Digestibility of Peanut and Sesame Seeds. In *Food Sci. Technol. Res* (Vol. 17, Issue 1).

[7] Flívia, F. de J. S., Julia, E. A. de S., Nara, O. S. S., Carlos, R. S., & Thais, F. de J. (2017). Standardizing germination tests for quinoa seeds. *African Journal of Agricultural Research*, *12*(3), 155–160. https://doi.org/10.5897/ajar2016.11820

[8] Graf, B. L., Rojas-Silva, P., Rojo, L. E., Delatorre-Herrera, J., Baldeón, M. E., & Raskin, I. (2015). Innovations in Health Value and Functional Food Development of Quinoa (Chenopodium quinoa Willd.). *Comprehensive Reviews in Food Science and Food Safety*, *14*(4), 431–445. https://doi.org/10.1111/1541-4337.12135

[9] Hussain, M. I., Farooq, M., Syed, Q. A., Ishaq, A., Al-Ghamdi, A. A., & Hatamleh, A. A. (2021). Botany, nutritional value, phytochemical composition and biological activities of quinoa. In *Plants* (Vol. 10, Issue 11). MDPI. https://doi.org/10.3390/plants10112258

[10] Kiptanui, E. B., Kunyanga, C. N., Ngugi, E. K., & Kimani, D. E. (2022). Optimization of fermentation and malting process of sorghum beverage and effects on nutritional quality. *African Journal of Food Science*, *16*(10), 252–260. https://doi.org/10.5897/ajfs2022.2211

[11] Kivilcim Kilinc, O. (n.d.). *Bioactivity of Triterpene Saponins from Quinoa (Chenopodium Quinoa Willd.)*.

[12] Lutz, M., & Bascuñán-Godoy, L. (2017). The Revival of Quinoa: A Crop for Health. In *Superfood and Functional Food - An Overview of Their Processing and Utilization*. InTech. https://doi.org/10.5772/65451

[13] M. L. Revanna, S. M. P., B. Kalpana, U. R., & Madhusudan, N. M. (2021). Quinoa (Chenopodium quinoa) Grains Processing and its Value Added Products. *International Journal of Current Microbiology and Applied Sciences*, *10*(4), 681–691. https://doi.org/10.20546/ijcmas.2021.1004.068

[14] Manoel Maradini-Filho, A., & Br, A. M. (2017). Citation: Maradini-Filho AM. Quinoa: Nutritional Aspects. In *J Nutraceuticals Food Sci* (Vol. 2, Issue 1). http://www.imedpub.comhttp://nutraceuticals.imedpub.com/archive.php

[15] Nadiah, F., Anwar, S., & Zulkifli, M. (n.d.). *Inaugural Symposium of Research and Innovation for Food (SoRIF)*.

[16] Nadian, N., Azizi, M. H., Abbastabar Ahangar, H., & Aarabi, A. (2021). Textural and sensory characteristics of sugar-free biscuit formulated with quinoa flour, isomalt, and maltodextrin. *Food Science and Nutrition*, *9*(12), 6501–6512. https://doi.org/10.1002/fsn3.2564

[17] Nkhata, S. G., Ayua, E., Kamau, E. H., & Shingiro, J. B. (2018). Fermentation and germination improve nutritional value of cereals and legumes through activation of endogenous enzymes. In *Food Science and Nutrition* (Vol. 6, Issue 8, pp. 2446–2458). Wiley-Blackwell. https://doi.org/10.1002/fsn3.846

[18] *nutrients and anti nutrients*. (n.d.).

[19] Pathan, S., & Siddiqui, R. A. (2022). Nutritional Composition and Bioactive Components in Quinoa (Chenopodium quinoa Willd.) Greens: A Review. In *Nutrients* (Vol. 14, Issue 3). MDPI. https://doi.org/10.3390/nu14030558

[20] Pd, W., Vs, P., Sg, D., & Gp, R. (2022). Studies on standardization of malting process for quinoa seeds (Chenopodium quinoa). *~ 423 ~ The Pharma Innovation Journal*, *11*(12), 423–427. www.thepharmajournal.com

[21] Samtiya, M., Aluko, R. E., & Dhewa, T. (2020). Plant food anti-nutritional factors and their reduction strategies: an overview. In *Food Production, Processing and Nutrition* (Vol. 2, Issue 1). BioMed Central Ltd. https://doi.org/10.1186/s43014-020-0020-5

[22] Sharma, S., Kataria, A., & Singh, B. (2022). Effect of thermal processing on the bioactive compounds, antioxidative, antinutritional and functional characteristics of quinoa (Chenopodium quinoa). *LWT*, *160*. https://doi.org/10.1016/j.lwt.2022.113256

[23] Suneetha, J., & Bethapudi, A. K. (2019). *Processing technologies and health benefits of quinoa*. https://www.researchgate.net/publication/333532337

[24] Thakur, P., Kumar, K., Ahmed, N., Chauhan, D., Eain Hyder Rizvi, Q. U., Jan, S., Singh, T. P., & Dhaliwal, H. S. (2021). Effect of soaking and germination treatments on nutritional, anti-nutritional, and bioactive properties of amaranth (Amaranthus hypochondriacus L.), quinoa (Chenopodium quinoa L.), and buckwheat (Fagopyrum esculentum L.). *Current Research in Food Science*, *4*, 917–925. https://doi.org/10.1016/j.crfs.2021.11.019

[25] Urbano, G., Aranda, P., Vílchez, A., Aranda, C., Cabrera, L., Porres, J. M., & López-Jurado, M. (2005). Effects of germination on protein composition and nutritive value in Pisum sativum, L. *Food Chemistry*, *93*(4), 671–679. https://doi.org/https://doi.org/10.1016/j.foodchem.2004.10.045

[26] Wu, L., Wang, A., Shen, R., & Qu, L. (2020). Effect of processing on the contents of amino acids and fatty acids, and glucose release from the starch of quinoa. *Food Science and Nutrition*, *8*(9), 4877–4887. https://doi.org/10.1002/fsn3.1775